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Natural finishes for exterior timber

Untreated timber exposed to the weather will discolour and degrade under the influence of various physical and biological agencies. If it is desired to preserve the natural appearance of exposed timber, some form of surface treatment is, therefore, needed. The 'natural' finishes commercially available may be grouped as varnishes, exterior wood stains, and wood preservatives. The selection and use of these are discussed in this Digest.

Performance and durability of timber

Changes on exposure to the weather

Any wood exposed to sunlight and rain will in time lose its original colour. The change is due partly to loss of water-soluble extractives, which occurs quite rapidly, but mainly to the breakdown of lignin and other components in the wood by the ultra-violet components in sunlight, and subsequent removal of the breakdown products by rain. The end result is a surface consisting of a thin layer of loosely matted delignified wood fibres. In a clean dry atmosphere this may have an attractive silvery-grey appearance, but more commonly the surface will become streaked with dirt and darkened by fungal and iron stains. After periodic wetting and drying, the growth rings become emphasised, surface or deeper splits will occur and the component may distort.

Effects of fungi

Blue-stain fungi Blue-stain fungi are important contributors to the darkening of grey weathered wood. On sapwood, colonisation by blue-stain fungi takes place simultaneously with the weathering process, and even the heartwood of resistant species becomes affected after extended outdoor exposure has removed the natural fungicidal constituents of the wood.

The blackening in service of timber that has been treated with a varnish or exterior wood stain sometimes occurs because softwood infected by blue-stain becomes wet; more often it is because of new infection by spores deposited on the coating which germinate and penetrate it.

Once blue-stain has developed extensively under varnish, the natural colour of the wood cannot be restored. It is therefore recommended that wood be treated before varnishing with a preservative effective against blue-stain. With adequate maintenance, the fungicide content of exterior wood stains is normally sufficient to inhibit the development of blue-stain. Linseed oil provides a food substrate for staining fungi and is quickly colonised in suitable conditions; even when fungicide is incorporated, stains containing linseed oil are at greater risk than those which do not.

Decay organisms Wood rotting fungi are liable to attack timber if it remains wet for long periods. Exterior timbers not in contact with the ground are unlikely to decay if they are of 'moderately durable' or better species (see Table 1 of Digest 73, 1973 edition) but this applies only to heartwood; all sapwood is vulnerable to decay. If, therefore, timbers of a lower durability rating are used, or if appreciable amounts of sapwood are present, pre-treatment with a preservative is advisable.

Wood preservation

Although a natural finish will regulate the entry of water through lateral surfaces, this can occur at butt ends, joints and other areas that are inaccessible for initial application or maintenance. In addition, water can enter through lateral surfaces if the finish is allowed to deteriorate. Thus the use of a natural finish does not reduce the need for preservative treatment of non-durable species.

The main types of preservative used for the treatment of seasoned timber are creosote, water-borne salts and organic solvent types. Softwoods can be treated at the sawmill, before drying, by the boron diffusion process. All except creosote permit the subsequent application of a surface finish after drying. Most organic solvent preservatives, including those described as water-repellent, are designed for timber pre-treatment before finishing and should not be confused with the exterior wood stains which evolved from them. The latter contain fungicides but are designed primarily as finishes, often having very limited penetration.

Types of natural finish

Clear varnishes The clarity and depth of finish of newly varnished wood is difficult to equal by any

other means, but the treatment is expensive both in initial cost and maintenance.

Fully exposed varnish often has a short life, principally because of the tendency of most types to embrittle by weathering, so that in time they disintegrate under the stresses imposed by a wood substrate. Ultra-violet light can pass through the film and bleach or degrade the underlying wood surface. Many instances of premature varnish failure can be traced to detachment of this degraded wood surface layer; this is often brought about by water getting behind the film where end grain is exposed, for example at joints or unstopped nail holes, or as a result of damage.

These shortcomings are common to all of the varnish binders commonly used. Polyurethanes of the moisture-curing and two-pack types give good service indoors but the stresses generated within such a strong coating are sufficient to peel from the wood a degraded outer layer; the remnants of the coating are difficult to strip either mechanically or chemically. Unless there are exceptional requirements for toughness and abrasion resistance, polyurethanes are therefore best avoided outdoors.

In the past few years, materials have become available which show improved performance. In some, this is due to increased ultra-violet resistance achieved by the incorporation of organic stabilisers or inorganic extender pigments. The latter reduce gloss but they reinforce the film and promote failure by erosion rather than cracking or peeling, so that re-coating is easier. Others are designed to yield a soft extensible film which is less likely to delaminate from the wood.

Preparation and use. Varnish performs best on smooth-textured species; it should not be used on those that are prone to resin exudation. The wood should be free from cracks and defects and machined to a smooth finish; corners should be slightly rounded. Its moisture content at the time of varnishing should be 15–18 per cent. Nails and fixings should be of hot-dip galvanised steel, stainless steel or non-ferrous metal. Nail holes should be stopped with an exterior grade filler. Pre-treatment with an anti-stain solution, to prevent disfigurement by blue-stain fungi, is recommended, followed by three or four coats of varnish, lightly sanded between coats.

To minimise maintenance, a further coat must be applied before any loss of film integrity occurs. Local areas of failure might be made good by staining to restore colour before revarnishing, but major failure necessitates stripping the weathered coating and, usually, applying an exterior wood stain to even up any patchiness in colour before revarnishing.

Exterior wood stains

Exterior wood stains are of several types with no very clear-cut distinction between them. For convenience, they are classified here as colourless, semi-transparent, low-solids, high-solids and opaque. They have also been described as decorative wood preservatives, water-repellent preservative stains, water-repellent finishes and impregnation paints. They combine some of the characteristics of a surface coating with those of a water-repellent preservative and were developed to overcome the maintenance difficulties of varnishes but are quite unlike the traditional spirit or water stains which need further sealing. In weathering they erode away, without peeling or flaking, thus minimising the preparatory work in maintenance. Many are designed so that the resinous component penetrates into the wood and even two- or three-coat treatment leaves little residual film. By making the surface of the wood water-repellent, they prevent water wetting and penetrating. Most contain small amounts of finely dispersed pigment, which gives some protection against ultra-violet without unduly obscuring the grain pattern, and can be produced in shades varying from light-straw to black. They also contain fungicide and can thus provide surface protection against the physical and biological factors in weathering.

It is difficult to give guidance on the expected life of exterior wood stains. The numerous commercial products vary in performance, which is also strongly dependent on the conditions of exposure and the colour. Light colours are subject to some darkening and soiling in service so that a slightly darker shade may be needed for maintenance. Darker colours will mask the discoloration caused by weathering and blue-stain fungi and are more durable because they are more effective in absorbing ultra-violet light. On the other hand, dark surfaces increase solar heat gain so that drying is more rapid and the incidence of surface checking may be increased, particularly in softwoods. Experience to date suggests that in situations which are not exposed to full sun exterior wood stains perform as well as paint. Under conditions of full exposure the rate of erosion may be such that re-coating may be necessary after about three years, at least in the early years. This short maintenance interval may make exterior wood stains uneconomic on high-rise buildings where the cost of scaffolding is a significant proportion of that of the whole maintenance operation. More generally the need for more frequent maintenance is more than offset by the simplicity of the maintenance process, so that an overall saving in maintenance costs can result from the use of an exterior wood stain. Successive maintenance coats will cause a progressive loss in transparency and the appearance may eventually become so drab that it is necessary to remove old treatments and expose a fresh wood surface before restaining.

Exterior wood stains are reasonably tolerant of surface imperfections, eg splits, shakes and knots, and some can be used on rough sawn timber, where absorption is higher and the life of the treatment may

be longer. Surface checks are also less obvious on a rough surface. They are probably the most appropriate treatment for resinous wood species. Resin exudation can occur without disrupting the treatment and although the hardened resin which collects on the surface may be unsightly, it can be scraped off prior to maintenance. Dark stains will aggravate the problem because of their greater heat absorption. Many stains, especially penetrating types, are suitable for use on plywood. Checks which develop in the face veneer do not impair the adhesion of the stain and can be treated with stain during maintenance.

Colourless These are essentially hydro-carbon solutions containing resin and fungicide but no pigment. Some are recommended for overcoating pigmented stains, to improve water-repellence and weather resistance, but most are used for the pre-treatment of non-durable wood species by immersion or double vacuum techniques to protect against fungal decay prior to the application of a surface finish; they are sometimes brush-applied. They give no protection against ultra-violet light but as they inhibit fungal staining they will, unless conditions are very conducive to mould growth, permit the wood to weather to a clean, light-grey colour. To maintain this effect, regular retreatment is necessary.

Semi-transparent *Madison formula.* This consists of a boiled linseed oil binder, fortified with paraffin wax to give increased water repellency, earth pigments and fungicide. It is intended as a penetrating stain and imparts an oiled apearance to the wood. One or two coats should be applied sparingly, because although excess material left on the surface will increase protection, the soft and slightly tacky film will darken and pick up dirt in service. On sheltered aspects, disfigurement by blue-stain fungus may occur. It is suitable for the treatment of sawn or planed wood and plywood, but not for situations where it will be subjected to abrasion or may come into contact with clothing. Because it contains wax, over-painting is only successful after it has been well weathered.

Low-solids. These are generally of low viscosity, to ensure good penetration, and leave the texture of the wood unaltered or with only a slight sheen. Because of their very slight film thickness, penetrating stains offer little resistance to the passage of water vapour between atmosphere and wood. The moisture content of the wood may, therefore, fluctuate rather widely in service and the design should make provision for the consequent movements. Excessive movement of cladding treated with penetrating stain has sometimes led to distortion of the boards and nail-pulling. Surface splitting may occur in wood species subject to large dimensional movement if excessive drying occurs during prolonged periods of dry weather. This problem is more marked on wood treated with dark stains as these are most subject to solar heat gain. The splits rarely extend to any great depth but they may, nevertheless, breach the protective envelope. Experience has shown that this does not increase the risk of fungal decay since the moisture content of treated wood does not remain at a high level for long periods and penetration of stain into the splits during maintenance will then make good any loss in protection. There is some evidence that water-repellent grades of preservative are especially advantageous for wood which is to be protected with stain because of their stabilising effect on the timber.

The low resistance of penetrating stains to moisture vapour transport may give rise to a problem peculiar to plywood. Fluctuations in moisture content will result in a slow diffusion of water-soluble salts present in the glue to the face of the panel. Normally these would be removed by rain but where the board is protected from direct rainfall, a white deposit may gradually build up and mar the appearance. The salts can be removed by washing with water but the problem will recur until all of the salts have been removed.

Penetrating stains can be used to good effect on interior timbers, but these products contain fungicide which could present a health hazard and an assurance should be sought from the manufacturer that this is not the case before using them where they could come in contact with food or the person.

High-solids. Because of their higher resin content, a two- or three-coat application of these stains will produce a noticeable film on the wood. Unlike varnish films, this is generally soft and flexible at first and will usually weather by erosion, though instances of embrittlement and flaking have been observed. High-solids stains require less frequent maintenance than the penetrating types, at least initially. They also have higher resistance to water-vapour transfer and treated wood is therefore less likely to suffer surface checking.

Opaque Opaque stains are intermediate between a paint and a stain. They have low gloss but the texture of the wood is usually discernible through the coating because of differences in penetration within the growth rings. They contain fungicide and are designed to weather by erosion, for easy maintenance.

Opaque stains may be solvent-borne or water-borne. Some are so highly pigmented as to be regarded as exterior emulsion paints; emulsion polymers have a short drying time and allow the painting of new wood to be completed in one day. Many of the opaque stains can be used over weathered but otherwise sound paintwork.

Preparation and use

The timber should be clean and dry, and installed at an appropriate moisture content. Exposed nails and fixings should be of hot-dip galvanised steel, stainless steel or non-ferrous metal. Joinery in wood species susceptible to decay should be treated with a water-repellent preservative, preferably by the double vacuum process, because a brush-applied stain does not bridge the joints in joinery and does little to prevent water uptake at end grain.

Standard softwood joinery often includes blemishes such as knots, splits, shakes and blue-stain which, with the possible exception of blue-stain, will remain visible after finishing. If this is not acceptable, a higher quality of timber must be specified. A standard of joinery which might be acceptable for painting may not be adequate for finishing with stain, because fixings, unsightly gaps and wide glue lines will not be concealed and the joinery could be subjected to greater movement. The joinery should be machined to a high standard as any torn grain or marks introduced during machining or sanding will be emphasised by the stain finish. Hardwood joinery is usually of a high standard. The timber is relatively impermeable and dimensionally stable so that any finish fulfils mainly a cosmetic function. If good glazing practice is observed, the use of stains presents few problems.

Most exterior wood stains are applied in two or three coats; care should be taken to avoid lap marks. Stains should not be splashed or allowed to run on to adjacent brick or stonework.

Glazing

With most types of stain, putty glazing is not suitable and in new work it is more satisfactory to design for bead fixing (see BS CP 152 : 1972). Where bead fixing is not possible, either a sealant or neoprene glazing system is recommended.

Preservatives as natural finishes

Creosote The low cost and preservative effectiveness of creosote ensure its continued use for fencing, agricultural buildings, etc, but as a brush-applied decorative treatment it has some shortcomings. It fades relatively quickly on south-facing aspects and yet, unless weathered for several years, will bleed into subsequently applied coatings. It is unpleasant to handle and offers a limited choice of shades. Refined grades are light in colour but they are generally less permanent than the established material.

Copper chrome arsenic salts Timber treated with CCA salts is used increasingly as cladding and for other outdoor purposes; it has a not unpleasant green cast which, in service, is subject to gradual greying but the fungicide should prevent the growth of algae or darkening by blue-stain fungi. Usually it is given a further surface finish, often an exterior wood stain.

Treatments for exterior timbers (softwoods and hardwoods)

Application	Exterior wood stain					Varnish	Creosote	Preservative requirements[1]
	Low-solids	High-solids	Madison formula	Opaque	Colour-less			
Boarding Bargeboards Fascias Soffits	•	•	•	•	•(3)	•	•	Building Regulations (England and Wales) and Building Standards (Scotland) name timbers which require treatment when used as boarding and those which can be used untreated.
Plywood	•		•				•	For situations not covered by these Regulations, preservative treatment is advisable for timbers rated[2] as 'perishable' or 'non-durable' or if appreciable quantities of sapwood are present.
Joinery	•	•		•		•		Preservative treatment is necessary for redwood, hemlock and spruce (see PRL Tech Note 24). If sapwood is excluded, timbers rated as 'moderately durable' or better can be used without preservative treatment.
Gates and fences	•				•(3)		•	Unless rated as 'durable' or 'very durable' and sapwood is excluded, all timber in contact with the ground should be preservative treated.
Sheds	•	•	•	•	•(3)		•	For timbers out of ground contact, preservative treatment for 'perishable' and 'non-durable' timbers is advisable. Where systematic maintenance can be ensured, repeated application of the preservative finish, eg creosote or exterior wood stain, may suffice.
Benches	•			•	•(3)			
Handrails	•			•	•(3)	•(4)		

NOTES (1) Only recommendations of a very general nature can be given. More detailed recommendations will depend on life requirements and characteristics of the timber used.
(2) Durability ratings are those described in PRL Technical Note No 40.
(3) Only if it is desired to achieve weathered silver-grey effect.
(4) Suitable, but limited life.

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